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EFFECT OF FERTIGATION OF N AND K ON PHYSIOLOGICAL PARAMETERS AND YIELD OF TURMERIC TRANSPLANTS (*Curcuma longa* L.) VAR. CO 2

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ABSTRACT

An experiment was conducted at college orchard, Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore from 2014 to 2015 to study the effect of fertigation of N and K on yield and quality of turmeric transplants. The experiment consisted of nine treatments replicated three times in a Randomized Block Design. The results showed that the fertigation treatment with 125 % levels of N and K through water soluble fertilizers recorded significantly superior physiological parameters viz., leaf area, leaf area index, chlorophyll a, chlorophyll b and total chlorophyll content and yield characters viz., yield per plant (401.00 g), yield per plot (105.65 kg/25 m^2) estimated yield (42.26 t/ha) and estimated cured rhizome yield (7.67 t/ha) of turmeric transplants. On the basis of good performance on yield, fertigation with 125 % levels of N and K through water soluble fertilizers can be employed for turmeric transplants.

KEYWORDS: Curcuma longa L., Turmeric Transplants, Fertigation, Physiology, Yield

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INTRODUCTION

Turmeric (*Curcuma longa* L.; Family: Zingiberaceae) is rhizomatous plant cultivated in many warm regions of the world encompassing the Caribbean Islands, China, Japan, India, Korea, Pakistan, Philippines, Malaysia, Myanmar, Sri Lanka, Thailand Vietnam, and Central America. Among these, India dominates the world turmeric market with 80% of the production and more than 60% share in trade (http://turmericworld.com/production.php; accessed on 02/02/16).

In turmeric, improper nutritional management practices and inadequate irrigation during critical crop growth stages can be considered as foremost factors contributing to low yields. Among the sophisticated hi-tech methods practiced, drip irrigation has proved its superiority due to direct application of water in the vicinity of root zone. Under drip irrigation, the spatial distribution of soil moisture and consequently crop roots are restricted to a small volume of soil directly below the emitters such as restriction has important implications for optimum fertilizer placement (Selvakumar, 2006). Being a nutrient exhaustive crop, turmeric has been known to generally respond well to increased soil fertility levels (Subramanian *et al*., 2001). Owing to its long duration and high productivity, it requires heavy input of fertilizers. Fertigation has found to dramatically improve the yield and quality of many horticultural crops. Turmeric transplants are produced from single bud rhizome. During their growth period, it will require more quantity of nutrients from the external source. As like that of the tissue culture plants, turmeric transplants require frequently nutrition. While fertigation can be practiced using conventional fertilizers such as urea and potash with reduced costs, use of water soluble fertilizers may be effectively employed to

improve productivity. With this background in consideration, the present study was taken up in turmeric var. CO 2 to evaluate the effects of different levels of N and K on leaf chlorophyll content and yield characters.

MATERIALS AND METHODS

A field experiment to study the effect of fertigation of N and K fertilizers on physiological parameters and yield of turmeric transplants (*Curcuma longa* L.) var. CO 2 was carried out at the college orchard, Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period from 2014 to 2015. The experiment was laid out in randomised block design, replicated three times. Raised beds of 25 m length, 1 m breadth, 20-25 cm height were formed and protray raised turmeric transplants of one month old having two fully opened leaves produced from single bud rhizomes were planted on first week of August in paired row system. A spacing of 45 cm between rows within a paired row, 55 cm between two adjacent paired rows and 15 cm within each row was maintained. In treatments receiving fertigation, drip laterals were laid along the length of each paired row at the centre with the spacing kept at 1 m between two adjacent laterals. In control plot, instead of drip laterals, provision for surface irrigation was provided for the paired rows. A venturi assembly was used for mixing fertilizer with irrigation water.

The fertilizers are applied through drip irrigation at weekly intervals by following the schedule by which 40 % of total N and 20 % of total K were applied from 1st to 4th weeks, 10 % of total N and 10 % of total K were applied from 5th to 8th weeks, 30 % of total N and 30 % of total K were applied from 9th to 17th weeks. The remaining quantity of 20 % N and 40 % K were applied from 18th to 34th weeks. The details of the treatments were as follows,

T_1: Control – 100 % recommended dose of NPK - 150:60:108 kg/ha - through straight fertilizer *i.e*., Urea & MOP by soil application + surface irrigation

T_2: Fertigation of N+K @ 125 % through straight fertilizers – once in a week

T_3: Fertigation of N+K @ 100 % through straight fertilizers – once in a week

T_4: Fertigation of N+K @ 75 % through straight fertilizers – once in a week

T_5: Fertigation of N+K @ 50 % through straight fertilizers – once in a week

T_6: Fertigation of N+K @ 125 % through water soluble fertilizers – once in a week

T_7: Fertigation of N+K @ 100 % through water soluble fertilizers – once in a week

T_8: Fertigation of N+K @ 75 % through water soluble fertilizers – once in a week

T_9: Fertigation of N+K @ 50 % through water soluble fertilizers – once in a week

The leaf area was analyzed from the procedure given by Rao *et al.* (1994) and the formula suggested by Watson (1956) was employed for the calculation of leaf area index. Chlorophyll content was analyzed from the procedure given by Yoshida *et al*. (1971). The crop was harvested after ascertaining the maturity. Yellowing and drying of the leaves as well as cracking of the soil were considered as indications of maturity. The yield observations were taken randomly from five plants in each plot (25 m^2).

RESULTS AND DISCUSSIONS

The treatments differed significantly among each other in the different stages for leaf area and ranged from 93.59 (30 DAP) to 211.78 cm^2 (210 DAP). Larger leaf area per plant was produced by T_6 (211.78 cm^2) at 210 DAP. This was followed by T_7 with the leaf area of 210.23 cm^2. The least leaf area per plant was noticed in T_1 (171.05 cm^2). Large leaf area is one of the major contributor for high photosynthetic rate in turmeric (Subramanian *et al*., 2001). Leaf Area Index (LAI) has showed an increasing trend and reached maximum at 210 DAP. It was found that fertigation had significant effect on LAI during the period of crop growth. The values of LAI varied significantly from 0.47 to 4.65 at different stages of crop growth. At 210 DAP, higher LAI was recorded by the T_6 (4.65), followed by T_7 (4.36). Lower LAI was found in T_1 (2.97).

The leaf chlorophyll content, key factor in determining the rate of photosynthesis, is also considered as an index of the metabolic efficiency of plants. This pigment, responsible for harnessing solar energy and converting it into chemical energy, exhibits a differential pattern in its accumulation in response to nutrients applied through fertigation. Chlorophyll content in the leaves was estimated at three stages *viz.*, 60, 120 and 210 DAP and differed significantly among the treatments (Table 1). The treatment T_6 registered significantly the highest chlorophyll 'a' at three stages of estimation (0.428, 0.646 and 0.904 mg g^{-1}) and T_1 registered significantly the least chlorophyll 'a' (0.310, 0.431 and 0.704 mg g^{-1}) at three stages of estimation. Among the three stages, higher chlorophyll 'a' contents in the range of 0.704 (T_1) to 0.904 (T_6) mg g^{-1} were recorded at 210 DAS. Similar findings were also reported by Krishnamoorthy and Soorianathasundaram (2014) in turmeric cv. BSR 2.

Chlorophyll 'b' contents were higher in T_6 at all the three stages of observation. T_1 registered significantly the least chlorophyll 'b' content in these stages. Chlorophyll 'b' contents were higher at 210 DAP and in the range of 0.484 mg g^{-1} (T_1) to 0.590 mg g^{-1} (T_6). The phenomenon of increased chlorophyll content with increased nutrition, as observed in the present study, was also reported earlier by several workers (Josefina *et al*., 2003; Prabhu, 2006; Sivakumar, 2007).

Among the different treatments, the total chlorophyll contents were significantly least in T_1 at three stages of observations (0.521, 0.836 and 1.487 mg g^{-1}) (Table 1). The highest total chlorophyll contents were recorded by T_6 at 60 (0.698 mg g^{-1}) and 210 DAP (1.670 mg g^{-1}). At 120, DAP T_7 recorded maximum total chlorophyll content (1.085 mg g^{-1}). In the present study, general increases in chlorophyll content were noted upto 210 days and then a declining trend was observed which coincided with the onset of leaf senescence. In many crop plants chlorophyll degradation has been observed with leaf senescence (Selvaraj *et al*., 1997).

The fresh rhizome yield per plant, per plot and the estimated yield per hectare varied significantly among different treatments (Table 3). The fresh rhizome yield per plant varied from 317.00 to 401.00 g. Among the treatments, fertigation of N+K @ 125 % through water soluble fertilizers – once in a week (T_6) recorded higher per plant yield (401.00 g), plot yield (105.65 kg / 25 m^2) and the estimated yield (42.26 t/ha) respectively. Fertigation with the higher levels of N and K especially in water soluble forms has definitely influenced the growth and physiological attributes, which reflected in higher growth, dry matter production, yield and yield related traits. Better nutrient availability in these treatments could be the crucial factor as Fontes *et al*. (2000) and Dangler and Lacascio (1990) have pointed out that application of N and K in combination with drip irrigation maximize the mobility of nutrients around the root zone. The treatment T_1 registered significantly the lowest yield with respect to per plant yield (317.00 g), plot yield (85.35 kg / 25 m^2) and the estimated yield (34.14 t/ha) respectively. Enhanced yield parameters with 100 and 125 % levels N and K fertilizer application

demonstrates better response of the crop to improved nutrient availability. A similar finding of increase yield under drip ferigation with water soluble fertilizers was reported by Krishnamoorthy and Soorianathasundaram (2014) in turmeric. Higher yield obtained with drip fertigation might be due to maintenance of favourable soil water status in the root zone, which inturn helped the plants to utilize moisture as well as nutrients more effectively from the limited wetted area. The above results also supported higher fertilizer use efficiency and nutrient uptake observed by the same treatment.

CONCLUSIONS

Studies taken up indicated that a dosage of 125 % of N and K level through fertigation of water soluble fertilizers resulted in higher yield and rhizome characters of turmeric transplants compared to conventional method of soil application and surface irrigation.

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APPENDICES

Table 1: Influence of Straight and Water Soluble Fertilizers on Leaf Area and Leaf Area Index

Treatments	Leaf Area (cm^2)				Leaf Area Index			
	30 DAP	60 DAP	120 DAP	210 DAP	30 DAP	60 DAP	120 DAP	210 DAP
T_1	93.59	127.88	165.22	171.05	0.47	1.14	2.29	2.97
T_2	108.95	177.30	198.60	209.46	0.66	1.87	3.36	4.16
T_3	156.93	163.05	195.16	199.81	0.92	1.63	3.14	3.77
T_4	125.15	135.39	173.64	183.89	0.84	1.30	2.56	3.43
T_5	104.84	129.31	174.18	177.84	0.67	1.26	2.49	3.14
T_6	150.05	189.13	201.50	211.78	1.10	2.16	3.87	4.65
T_7	170.29	182.55	201.06	210.23	1.18	2.00	3.70	4.36
T_8	140.56	165.13	187.89	204.62	0.88	1.70	3.15	4.04
T_9	115.74	149.65	181.61	188.11	0.66	1.49	2.89	3.53
Mean	**129.57**	**157.71**	**186.54**	**195.20**	**0.82**	**1.62**	**3.05**	**3.78**
SEd	**4.5288**	**4.8932**	**6.0617**	**4.2475**	**0.0432**	**0.0749**	**0.1270**	**0.1143**
CD (0.05)	**9.6007**	**10.3732**	**12.8504**	**9.0045**	**0.0915**	**0.1587**	**0.2693**	**0.2423**
CD (0.01)	**13.2281**	**14.2925**	**17.7056**	**12.4066**	**0.1261**	**0.2187**	**0.3710**	**0.3339**

Table 2: Influence of Straight and Water Soluble Fertilizers on Chlorophyll Contents

Treatments	Chlorophyll 'a' (mg g^{-1})			Chlorophyll 'b' (mg g^{-1})			Total chlorophyll (mg g^{-1})		
	60 DAP	120 DAP	210 DAP	60 DAP	120 DAP	210 DAP	60 DAP	120 DAP	210 DAP
T_1	0.310	0.431	0.704	0.211	0.316	0.484	0.521	0.836	1.487
T_2	0.405	0.606	0.867	0.252	0.409	0.556	0.657	1.018	1.628
T_3	0.381	0.527	0.819	0.236	0.391	0.562	0.627	0.950	1.511
T_4	0.362	0.492	0.781	0.229	0.372	0.510	0.591	0.882	1.457
T_5	0.358	0.486	0.731	0.223	0.352	0.499	0.581	0.877	1.439
T_6	0.428	0.646	0.904	0.291	0.432	0.590	0.698	1.042	1.670
T_7	0.413	0.622	0.895	0.270	0.424	0.584	0.671	1.085	1.643
T_8	0.398	0.591	0.844	0.244	0.397	0.564	0.642	0.978	1.579
T_9	0.374	0.517	0.796	0.234	0.387	0.523	0.610	0.930	1.498
Mean	**0.381**	**0.546**	0.816	**0.243**	**0.387**	0.541	**0.622**	**0.955**	1.546
SEd	**0.0059**	**0.0096**	**0.0160**	**0.0055**	**0.0073**	**0.0084**	**0.0149**	**0.0136**	**0.0289**
CD (0.05)	**0.0125**	**0.0203**	**0.0339**	**0.0117**	**0.0154**	**0.0177**	**0.0316**	**0.0288**	**0.0613**
CD (0.01)	**0.0172**	**0.0280**	**0.0467**	**0.0162**	**0.0213**	**0.0244**	**0.0436**	**0.0396**	**0.0845**

Table 3: Influence of Straight and Water Soluble Fertilizers on Yield Parameters

Treatments	Yield per plant (g)	Yield per plot (25 m^2)(kg)	Estimated fresh rhizome yield (t/ha)	Estimated cured rhizome yield (t/ha)
T_1	317.00	85.35	34.14	6.02
T_2	389.00	99.32	39.73	7.10
T_3	374.00	93.06	37.22	6.61
T_4	350.00	87.48	34.99	6.18
T_5	329.00	86.57	34.63	6.11
T_6	401.00	105.65	42.26	7.67
T_7	396.00	100.52	40.21	7.22
T_8	381.00	95.02	38.01	6.77
T_9	365.00	89.62	35.85	6.35
Mean	**366.89**	**93.62**	**37.45**	**6.67**
SEd	**7.0746**	**1.8321**	**0.6486**	**0.1615**
CD (0.05)	**14.9976**	**3.8839**	**1.3749**	**0.3423**
CD (0.01)	**20.6641**	**5.3513**	**1.8944**	**0.4717**